U. S. DEPARTMENT OF COMMERCE

Technical News Bulletin

of the

National Bureau of Standards

★ *Issued Monthly* ★

Bureau of Standards

MAY 11 1939

Washington **MAY 1939**[1] **Number 265**

CONTENTS

The National Bureau of Standards as a service organization.
Meeting of American Physical Society.
New units of electricity and light.
Absolute determination of the ampere.
Torque between concentric single-layer coils.
Gold-chromium resistance alloy.
Cadmium-cadmium sulfate half-cell for measuring potentials in the earth.
Distribution of ozone in the stratosphere.
Specification of color tolerances.
Efficiency of a rotary distillation column.
Behavior of rubber hydrocarbon in a molecular still.
Toggle clamp for rubber tensile specimens.
pH value of papers.
Base-combining capacity of wool.
Flameproofing of textiles.
Indentation and recovery of floor coverings.
Structural properties of "Wheeling Long-Span Steel Floor."
Measuring wear of bearing surfaces.
Boiler-furnace slags.
Determination of boron in special glasses.
Economic features of X-ray protection.
Simplification of varieties and classification of metallic cartridges.
Simplification of shipping tags.
Silver research project to be continued.
New and revised publications issued during April 1939.
Mimeographed material:
Letter Circulars.
Report of the National Hydraulic Laboratory.
Recent Bureau articles appearing in outside publications.

THE NATIONAL BUREAU OF STANDARDS AS A SERVICE ORGANIZATION

The Bureau's services to the National and State Governments, American industry, and the general public were described in a brief address by Dr. Lyman J. Briggs at a meeting of the National Electrical Manufacturers' Association held at the Department of Commerce on March 31.

Dr. Briggs spoke, in part, as follows:

"The National Bureau of Standards is a service organization. It has no police or enforcement responsibilities, nor does it desire such authority.

"One of the primary service functions of the Bureau is the custody and maintenance of the national standards of measurement. Industrial efficiency demands that the working standards of industry be kept in close accord with these national standards. To this end, the Bureau gladly undertakes for any person the testing of any standard or instrument, the correct use of which necessitates its comparison with the national standards. The law provides that such tests shall be made free for Federal and State agencies. For others a fee covering the cost of the work is charged. The importance of this service can hardly be overemphasized. For example, the mass production of interchangeable parts in this country has been made possible through ceaseless checking of the working standards of industry with the national standards maintained at the Bureau.

"The Federal Government buys its supplies on the basis of specifications. Open competitive bidding, combined with a good specification, is the fairest method of making Federal purchases that has been developed. But there is another essential step in this procedure. The delivered goods must be tested to determine whether they fully meet the specifications. Such testing for other Government agencies represents a second large service activity of the Bureau. This should be extended, be-

[1] Published with approval of the Director of the Budget.

cause the omission of acceptance tests by any purchasing agent defeats the whole procedure.

"Federal specifications are written by committees of technical men drawn from all branches of the Government, working under the general guidance of an executive committee. The Bureau takes an active part in this work, along with other agencies, but all Federal specifications are fundamentally of an interdepartmental nature. Over 1,200 of these specifications are now in effect. No specification in these days can safely be considered as a finished, perfected thing. New products are coming into the market, new manufacturing processes are being used, new facts regarding materials are being established. Federal specifications are constantly being revised and strengthened in the light of these developments, and new ones are being added.

"Research is the very foundation of the Bureau's work. Through research the national standards of measurement are extended, developed, made more exact. Better methods are devised for comparing the working standards of industry with the national standards. Research provides the basic information for writing new and better specifications. Through research more rapid methods of testing products are developed, including accelerated tests to determine the probable life and performance of a product in long-time service. Through research the essential and the characteristic properties of materials are determined. Facts established through painstaking research constitute a national heritage that can never be taken away, a foundation upon which we can safely build. No better national investment could be made than to extend this research service.

"Research enables the members of the Bureau's staff to speak with firsthand knowledge of their specialized subjects. The extent to which this knowledge is utilized and appreciated by industry may be illustrated by the results of a 3-day survey conducted last March. During this 3-day period 427 men came directly to the Bureau to consult members of the staff on technical matters. During the same period, 800 letters requesting technical information were received; 400 additional letters requested Bureau publications; 800 calls for information came in by telephone.

"I close by repeating what I said in the beginning, the National Bureau of Standards is an organization of service—to the Federal and State Governments, to industry, and to consumers."

MEETING OF AMERICAN PHYSICAL SOCIETY

The spring meeting of the American Physical Society was held on April 27 and 28 at the Bureau and on April 29 at the Catholic University of America. Two papers were presented by members of the Bureau's staff, as follows:

Determination of Quenching Rates in an Aluminum Alloy of the Duralumin Type, by Hugh L. Logan. A method of calculating the quenching rate used in the heat treatment of an aluminum alloy of the duralumin type, using photographically recorded time-temperature curves, was described, and results with a commercial alloy containing copper, magnesium, and manganese were given.

An Experimental Method for Measurement of Shearing Stresses in Turbulent Air Flow, by Harold K. Skramstad. This paper described a special type of hot-wire anemometer for measuring the shearing stress in turbulent air flow. In particular, this instrument has been used to measure the distribution of shearing stress in the boundary layer of a flat plate. The work is being carried on with the financial assistance of the National Advisory Committtee for Aeronautics.

NEW UNITS OF ELECTRICITY AND LIGHT

In pursuance of the program for establishment of new values for the units of electricity and light (Technical News Bulletin 225, January 1936; and 246, October 1937) the Bureau last year sent groups of standard cells and standard resistors to the International Bureau of Weights and Measures and standard lamps to the National Physical Laboratory of Great Britain, for comparison with similar standards from other countries. These standards have now been returned, and remeasurement at the Bureau shows that they remained very stable in value.

One of three standard resistors apparently changed in resistance by 1 part in a million, but the other two showed practically no change. Of 10 standard cells, none apparently changed by as much as 2 parts in a million. Such measurements give a very precise comparison with units now maintained in other countries, and also provide a basis for combining the results obtained in various countries on determinations of the values of the units by absolute measurements. The Bureau has reported results of its deter-

minations (see following item, and Technical News Bulletin 258, October 1938), but the international program has fallen behind schedule, particularly because no reports on electrical units have been received from the German national laboratory.

The lamps compared at the British laboratory were of two types, one representing candlepower derived directly from the new primary standard (blackbody radiator at the freezing point of platinum, 2,046° K), the other, candlepower of vacuum tungsten lamps at a color temperature of 2,360° K. On average values the agreement between the three laboratories taking part in the comparison is good, but further measurements are necessary to explain variations of results on individual lamps so as to increase the certainty of the values. Comparisons of standards for flux of light (lumens) must also be made, and this must be extended to include lamps of the gas-filled tungsten type before the new units can be put into practical use.

Because of the delays in the international program, it is evident that new values of the units cannot be introduced into use as of January 1, 1940, as was planned. Meetings of two committees dealing with the two classes of standards are to be held in Paris in June, and the International Commission on Illumination (which is concerned with the units of light) is scheduled to meet in Holland during the same month. It is expected that definite plans for the introduction of the new units can then be made and a new date set. The Bureau will then be prepared to recommend such legislation as is necessary to adopt the units in this country.

ABSOLUTE DETERMINATION OF THE AMPERE

The measurements which have been made at the Bureau to establish the value of the unit of electric current, the ampere, in terms of the mechanical units of length, mass, and time have been referred to in previous numbers of this Bulletin (TNB192, April 1933; and TNB206, June 1934). The current balance, as used in this work, is an apparatus consisting of a coil suspended from the pan of a very sensitive balance and two larger coils attached to the case of the balance, one above, the other below, the suspended coil. The dimensions of these coils and their distance apart must be accurately measured. When the coils are carrying a current, the force on the suspended coil can be measured by the balance. From this force and the known geometrical arrangement of the electric circuits, the current can be computed. The current so obtained is said to be expressed in absolute amperes. The absolute ampere, in connection with the absolute ohm is used to determine the electro-motive force of a standard cell in absolute volts.

In the Journal of Research for May, a report (RP1200) by Harvey L. Curtis, Roger W. Curtis, and Charles L. Critchfield, gives the details of measurement and the results obtained with improved coils. The coils of one set, which were wound with anodized aluminum ribbon, were much more compact than any previously used. The result obtained, however, is only slightly different from that obtained in the previous investigation.

TORQUE BETWEEN CONCENTRIC SINGLE-LAYER COILS

In RP1208 in the May Journal of Research, Chester Snow gives seven types of small correction terms which must be added to the formula for the torque or mutual inductance between concentric current sheets whose axes intersect at an angle θ. This principal term was developed in an earlier paper. The correction terms are necessary on account of:

(*a*) The discrete nature of the windings, actually wires of small diameter instead of the tape windings, which constitute a current sheet.

(*b*) The nature of the current distribution over the section of the wire.

(*c*) The effect of small variations in diameters of the cylindrical forms.

(*d*) The effect of small variations in pitch.

(*e*) The effect of errors in centering the coils.

(*f*) The effect of the axial components of current.

(*g*) The effect of the current in the lead wires.

GOLD-CHROMIUM RESISTANCE ALLOY

The gold-chromium resistance alloy previously investigated at the Bureau (TNB211, November 1934) seems to be ideally suited for the construction of very precise electrical measuring instruments, such as the bridges used in resistance thermometry. Further investigation, with particular reference to

this application of the alloy, has shown that after suitable heat treatment, the resistance of coils containing 2.1 percent of chromium is independent of temperature to within 1 part in a million from 18° to 35° C, and that the resistance of properly constructed coils is extremely stable. Consequently, it seems probable that a bridge made with gold-chromium alloy coils and without temperature control should be fully as good as the customary bridge with manganin coils and thermostatic control.

RP1206, by Theodore B. Godfrey, in the May number of the Journal of Research, contains the complete report of this work.

CADMIUM-CADMIUM SULFATE HALF-CELL FOR MEASURING POTENTIALS IN THE EARTH

In the control of stray currents from electric railways and in the design and regulation of cathodic protection circuits, it is frequently desirable to measure the potentials of buried structures with respect to a reference electrode which is in contact with the soil. The copper-copper sulfate half-cell, described in the April number of this Bulletin, is used for this purpose, but it has the disadvantage that the measured potential difference between the half-cell and iron is usually rather large, being approximately 0.6 volt. If the potential difference between the iron structures and the reference electrode were smaller, field potential measurements could be made more conveniently. The cadmium-cadmium sulfate half-cell has a potential near that of iron in the average soil. An investigation was therefore made by Scott Ewing, research associate of the American Gas Association at the Bureau, to determine whether this half-cell would be suitable in other respects for field measurements.

It was found that cadmium is considerably more stable in potential behavior than copper, and that cadmium electrodes, plated with spongy cadmium, are reproducible within 0.25 mv. The difference in potential between two cadmium-cadmium sulfate half-cells was measured when one of the half-cells was held at constant temperature while the temperature of the other was varied over the range from 0° to 50° C. These measurements were made using 10-percent $CdSO_4$ and saturated $CdSO_4.8/3H_2O$ solutions. By means of the observed relation between temperature and potential, potential measurements between two half-cells may be corrected to a common temperature. Polarization on various kinds of cadmium electrode surfaces in contact with several concentrations of cadmium sulfate was measured over the current density range which would be used in practice. The error caused by polarization can be reduced to 1.0 mv, at most, by the use of spongy cadmium, provided the current density does not exceed 0.16 ma per sq. cm.

From consideration of these data and the currents required for the operation of suitable deflection instruments, a half-cell for field use was designed. The arrangement and form of the half-cell are the same as that of the copper-copper sulfate half-cell previously described.

DISTRIBUTION OF OZONE IN THE STRATOSPHERE

Measurements of the spectral quality and total intensity of ultraviolet solar radiation at a fixed ground station, as well as similar measurements obtained at various elevations above the earth's surface, are reported in a paper (RP1207) by W. W. Coblentz and R. Stair in the Journal of Research for May.

For making measurements at a fixed ground station at a high elevation (Flagstaff, Ariz., elevation 2.2 km), a portable ultraviolet intensity meter, consisting of a balanced amplifier, *Ti*-photoelectric cell, and microammeter, was used. (BS J. Research 12, 231 (1934) RP647.)

For measuring solar radiation in the stratosphere an ultraviolet intensity meter (consisting of a *Cd*-photoelectric cell and filter radiometer connected with a balanced amplifier, relaxation oscillator, and radio transmitter), and a radio-operated barometer were transported aloft by means of unmanned balloons. The audiofrequency modulated radio wave, giving the intensity of the ultraviolet solar radiation and the altitude of the apparatus, was received and graphically recorded at a fixed ground station. (J. Research NBS 20, 185 (1938) RP1075.)

In the measurements at Flagstaff, Ariz., close parallelism was observed in the variation in filter transmission with variation in barometric pressure, in agreement with the well-known variation in the amount of atmospheric ozone that accompanies changes in air pressure. No such systematic variation in filter transmission with variation

in pressure of atmospheric aqueous vapor was observed.

A notable example is described where the wave of low barometric pressure preceded by 5 to 6 hours, an appreciable increase in atmospheric ozone, apparently indicating which was cause and which was effect, and suggesting a method of studying air circulation in the stratosphere.

In four balloon ascensions, made in June 1938, the photoelectric ultraviolet intensity meter and auxiliary radiotransmitting apparatus attained heights of 25 to 27 km (83,000 to 88,000 feet), penetrating about 65 percent of the ozone, most of which was localized in a layer extending from an elevation of 18 to 27 km, with a wide maximum of concentration at a height of about 25 km. At the highest elevation attained by the instruments, the intensity of the ultraviolet of short wave lengths was about 10 times that of direct sunlight at sea level.

SPECIFICATION OF COLOR TOLERANCES

Color tolerances have been applied at the Bureau by three methods: (1) Specification by permissible area on the mixture diagram of a fundamental colorimetric coordinate system (ICI or OSA systems) combined with stated tolerances restricting luminous transmission of samples viewed by transmitted light, or restricting luminous apparent reflectance of samples viewed by reflected light; (2) use of a standard and tolerance sample, delivered goods to depart from the standard color by not more than the tolerance, amount of color departure determined by direct visual estimate; and (3) specification of the "NBS unit of surface-color difference" which combines circular areas on the uniform-chromaticity-scale (UCS) triangle with a degree of lightness tolerance adjusted to the observing conditions for each particular type of sample. The combination of the chromatic and achromatic components of the unit is made by analogy with Euclidean geometry. Lightness is estimated as the square root of the luminous apparent reflectance. It is known that the presence of a conspicuous dividing line between the two surfaces to be compared interferes with the perception of the lightness difference between them, but affects only slightly the perception of chromaticity difference. Also, it has been found under inspecting conditions that a glossy finish on the sample interferes with the perception of color differences, the darker the samples, the greater the interference, there being little or no interference for near-white samples. Both the character of the dividing line and the gloss of the sample are taken into account in formulation of the NBS unit; color differences expressed in these units are intended to be proportional to estimates of size of color difference by direct visual inspection. The derivation of the formula defining the NBS unit is given, together with a summary of some of the data which have accumulated during the past 20 months since adoption of the unit. These data corroborate the formula in the main, but some of them suggest that the color spacing indicated by the uniform-chromaticity-scale triangle fails significantly to accord with estimates obtained in the inspection of samples. This partial failure of the UCS triangle to represent estimated color differences between actual samples seems to be related to the fact that the psychophysical data on which the UCS triangle is based refer to macular vision, but inspection of samples for color commonly involves a visual field subtending 20 or 30 times this angle. A revision of the third method of specifying color tolerances is thus foreshadowed. The Bureau's research work is directed toward the development of a unit of surface-color difference which shall take satisfactory account of the properties of the para-foveal portion of the normal retina.

EFFICIENCY OF A ROTARY DISTILLATION COLUMN

The improved packed and bubble-cap laboratory distillation columns, which have been developed in the past few years, have a separating efficiency corresponding to about one theoretical plate per 2.5 cm of height in the rectifying section. In connection with the work on the chemical constitution of petroleum carried on at the Bureau by the American Petroleum Institute Research Project 6, distillation columns of even greater efficiency are needed for separating hydrocarbons of eight or more carbon atoms per molecule. To this end, experiments were made by Beveridge J. Mair and Charles B. Willingham to determine the separating efficiency of a rotary distillation column of the type used by Pegram, Urey, and Huffman in fractionating mixtures of ordinary water and deuterium oxide.

A rotary column was built with a rectifying section 56 cm long and 5.1

cm in diameter. Tests were made at speeds of rotation ranging from 250 to 1,500 rpm and throughputs ranging from 1 to 10 ml of liquid per minute, using as rotating members (1) baskets with fine holes, (2) flat plates, and (3) cones. The binary system methylcyclohexane-normal heptane was used as the test mixture.

As reported in the May Journal of Research (RP1201), the lowest height equivalent to a theoretical plate was obtained with the conical rotating members spaced 0.64 cm apart, with which the following average results were obtained: Height equivalent to a theoretical plate, 1.04 cm; hold-up, 1.3 to 1.6 ml of liquid per theoretical plate; maximum throughput, 10 ml of liquid per minute. Within the reproducibility of these experiments there was no variation in height equivalents for throughputs from 2 to 10 ml of liquid per minute and speeds of rotation from 250 to 1,500 rpm.

Judging from these tests, it appears possible to install in a room of ordinary height, a laboratory rectifying column having a separating efficiency of from 200 to 250 theoretical plates.

BEHAVIOR OF RUBBER HYDROCARBON IN A MOLECULAR STILL

The special type of apparatus used in vacuum distillation, which has received the name of molecular still, has some unique features. The distance between the distilling and condensing surfaces is less than the mean free path of the molecules. Molecules proceed in a straight path to the condenser, and no recondensation takes place on the distillation surface. These surfaces must be close to one another to facilitate condensation and to minimize collisions. The still has been used with paraffin wax, cane sugar, petroleum fractions, and other substances, and it has been used to promote chemical reaction by molecular evaporation.

In the course of some work at the Bureau, W. Harold Smith and Henry J. Wing attempted the distillation of rubber with this type of still. The tendency for distillation to take place decreases with increasing molecular weight. Consequently, it seemed possible that molecules in rubber might be distilled if small and if the vapor pressure of the rubber could be increased sufficiently so that molecules would leave its surface. Three experiments, which will be described in the May Journal of Research (RP1202), were conducted to distill rubber in this way at 160° C. for varying periods, and with the condensing surface at different temperatures.

In one experiment, which was conducted for about 100 hours, the condensing surface was chilled by liquid air. A thin, transparent deposit, consisting of about 2 mg, appeared on the condensing surface. It was feebly extensible and did not recover completely when deformed. Its physical properties more nearly resembled rubber than those of other distillates. In a second experiment lasting 250 hours, solid carbon dioxide and acetone were used in the condenser; and in a third one, which was continuous during 140 days, the condensing medium was tap water at about 10° C. It was difficult to remove oxygen from the specimens of rubber which were used. Consequently, the distillates in these experiments may have been oxidized, at least in part. The distillation products were hard, transparent, and insoluble in ordinary solvents of rubber. In the third experiment the distillate amounted to about 20 mg. and showed an iodine number of 328 as compared with 370 for the original purified rubber, indicating that oxidation or cyclization or both may have taken place.

TOGGLE CLAMP FOR RUBBER TENSILE SPECIMENS

A new toggle clamp for rubber tensile specimens has been designed by William L. Holt and A. T. McPherson of the Bureau. It is an adaptation of the familiar wedge grips used for metal specimens, and consists essentially of parallel blocks, each carried on two short links in such a way that a rubber specimen placed between the blocks is gripped more tightly the greater the pull. The clamp was designed primarily for tubular specimens of electrical insulation, but is equally applicable to specimens in the form of strips or dumbbells. As reported in the Journal of Research for May (RP1204), insulation from No. 14 Performite wire tested with the new clamp showed values of the tensile strength approximately 20 percent higher, and ultimate elongation 10 percent higher than with the roll clamp. Insulation from ignition cable having a wall 0.1 in. in thickness showed a tensile strength 50 percent higher and an ultimate elongation 18 percent higher with the toggle than with the roll clamp. Tubular or strip specimens tested with the toggle clamp gave values of the tensile strength of the

order of only 5 percent lower than obtained with dumbbells of the same composition. Specimens breaking in the clamps, whether roll or toggle, gave a symmetrical distribution of values about the mode, while those breaking between the clamps showed a skew distribution. The coefficient of variation did not vary significantly with the type of clamp or shape of specimen, the numerical values ranging from 0.043 to 0.060 for tensile strength and from 0.017 to 0.035 for ultimate elongation.

pH VALUE OF PAPERS

The acidity of a paper, expressed as its pH value, is now considered one of the most important items on which to base an estimate of its lasting qualities. A relatively acidic paper will deteriorate despite any other properties it may have. The Government, in buying record paper accordingly requires that the pH value must meet a certain specification. It is, therefore, very important that a method of measuring the pH be available which will give values as reproducible as possible. Unfortunately, the methods in use at the present time have been found to give results which sometimes differ widely.

An improved method which is rapid and has good reproducibility, has been developed by Herbert F. Launer at the Bureau. It requires far less handling of the papers than previous methods, thus decreasing the probability of obtaining misleading results through contamination. Extraction is made at room temperature, since no advantage of using hot water, as prescribed by the method generally used, could be found. Reports on the method, given in RP1205 in the May Journal of Research, show that the pH values obtained by the new procedure are in good correlation with the chemical stability and with the percentages of alum used in the manufacture of the papers, and may, therefore, be said to represent the quality of the papers adequately. In studying these relationships, many varieties of experimental papers were used, which had been produced under carefully controlled conditions in the Bureau's semicommercial paper mill.

BASE-COMBINING CAPACITY OF WOOL

Wool fibers are composed principally of protein substances which contain chemical groups having acidic or basic properties. The state of combination of these groups is intimately related to the ability of the fibers to absorb moisture and dyes, to their elastic and tensile properties, and to their ability to withstand deterioration. The most direct method which has been used in determining the number of these groups in proteins involves the determination of the amount of acid or base bound by the material. Because of the inherent nature of wool, little difficulty is encountered in measuring the acid taken up. On the other hand, wool is so unstable in alkaline solutions that the amount of base combined cannot be determined by direct titration.

The results of an investigation by Milton Harris and Henry A. Rutherford, reported as RP1203 in the Journal of Research for May, show that the failure of wool to reach equilibrium with alkaline solutions under conditions of titration experiments is due to the reaction of base with the disulfide groups of the cystine. The data indicate that the extent of this reaction can be determined. They also afford confirmation of the earlier observation that the alkali degradation of the cystine in wool involves the loss of only one sulfur atom from each cystine molecule.

The apparent base-combining capacity increases with increasing duration of contact of wool with alkali and with increasing temperature, but the intrinsic base-combining capacity, obtained by making corrections for the dissolved protein and for the base bound by the sulfhydryl groups, becomes constant after approximately 2 hours. The most consistent data are obtained at a low temperature where it appears secondary reactions are greatly inhibited.

Determination of the amount of base absorbed from solutions of various concentrations indicates that a limiting amount of about 0.7 millimole per gram of wool is reached above concentrations of about 0.2 *N* sodium hydroxide. Because of discrepancies in the data obtained at concentrations greater than 0.3 *N*, it is suggested that this value be considered for the present as tentative.

FLAMEPROOFING OF TEXTILES

For certain uses textiles must be rendered as nearly fire-resistant as possible, and inquiries about methods for accomplishing this are frequently received at the Bureau. A new method has been developed for making fire tests of textiles in which a 7- by 1-in.

sample of a vertical edge is exposed to the flame. The testing method and recommended requirements were incorporated in a report to the Committee on Fire Proofing and Preservative Treatments of the National Fire Protection Association. Twenty samples of heavy cotton felt and 27 samples of cotton duck have been tested by this method at the request of the Procurement Division of the Treasury Department. Federal Specification CCC–D–746, entitled "Duck, Cotton; Fire, Water, and Weather Resistant", was issued during the month, the flameproofing requirements being based on tests conducted during the past year.

INDENTATION AND RECOVERY OF FLOOR COVERINGS

As part of the Bureau's research program on building materials for low-cost house construction, tests have been made by P. A. Sigler and Myrtle B. Woodward on various types of floor coverings to determine their relative merits as regards initial and 30-minute indentation under various loads, and the recovery after removal of the load. The results are presented in graphical form in Building Materials and Structures Report BMS14, copies of which are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each. The floor coverings tested included asphalt tile, pressed fiberboard, linoleums, felt-base floor coverings having various wearing surfaces, rubber, and wood.

While specifications are available for many kinds of floor coverings, they deal with the quality of each type, not with the relative qualities or characteristic features of various types. Yet comparable information of this kind is of direct interest to the consumer in selecting a floor covering to meet his particular needs. The ability of a floor covering to depress readily under foot is a desirable property from the standpoint of personal comfort in walking, but unless this property is coupled with an ability to recover to normal shape upon removal of temporary loads, the floor covering will soon present an irregular and unsightly surface.

In the selection of a floor covering, the nature of the exposure, walking comfort, and price are all of importance. The severity of the service can often be greatly reduced by the use of ample-sized and properly maintained casters or shoes under furniture, and by care to avoid abuse. If the floor covering must in normal service be exposed to highly concentrated or prolonged loads, the harder types of floors will usually be more satisfactory. Otherwise, greater comfort can be secured from coverings which indent readily under load and recover to normal shape upon its removal. The combination of resistance to abuse and high comfort can ordinarily be secured only in the higher-priced floor coverings.

STRUCTURAL PROPERTIES OF "WHEELING LONG-SPAN STEEL FLOOR"

As part of the program on the structural properties of low-cost house constructions, the Bureau tested six specimens of sheet-steel floor constructions submitted by the Wheeling-Corrugating Co. These consisted of sheet-steel, channel-shaped joists, assembled by welding the wide, overlapping upper flanges to form a continuous sheet-steel subfloor to which a hardwood-finish floor and a plaster ceiling were attached.

The specimens were subjected to transverse, impact, and concentrated loads, simulating the actual loads applied to the floor of a house. For each of these loads three like specimens were tested, the concentrated load tests being made on undamaged portions of the specimens used for the impact tests. The deformation under load and the set after the load was removed were measured for uniform increments of load, except for concentrated loads, for which the set only was determined. The strength under transverse load was also determined. The results are presented graphically and in a table in Building Materials and Structures Report BMS 15, which has just been released. Copies are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.

MEASURING WEAR OF BEARING SURFACES

Some months ago a new method for measuring accurately the wear which takes place on bearing surfaces of machinery was developed at the Bureau. The method consists in making minute indentations in the wearing surface by means of a specially shaped diamond point. As material is worn from the surface, the dimensions of the marks change with the amount of material removed. Measurements of these impressions then indicate quickly and ac-

curately the amount of wear that has taken place. The method is already being utilized in cooperation with other governmental agencies, and a private company has been licensed to build the equipment for general use.

BOILER-FURNACE SLAGS

The chemical reaction between coal-ash and boiler-furnace refractories is an important factor in damage to the latter. Both the ash and the fire-clay refractory are similar in that both are usually high in alumina and silica and both contain fluxes. With sufficient heat, melting, interaction, and subsequent corrosion of the refractory take place. T. A. Klinefelter is studying the temperatures and reaction at which slags of the boiler-furnace type become liquid, and hence corrosive. Since the coal ashes are not simple, single chemical compounds but mixtures of several or many compounds, portions of an ash may liquify at a given temperature while other portions remain relatively inert. For this reason, two ashes of approximately the same softening temperature, as determined by the ordinary tests, may give somewhat different results in point of corrosion, in the same furnace and under similar conditions. As a corollary, a chemical analysis of the ash, of itself, does not completely foretell the action of the slag formation. However, by carrying the mixtures to a temperature at which they become practically clear glasses and then observing the mineralization which takes place as cooling proceeds, it has been found that certain minerals will invariably form initially at rather definite temperatures. Examination of many representative coal ashes shows the main constituents to be silica, alumina, lime, and iron oxide. The most refractory mixtures of these, with Fe_2O_3 held at 10 percent, are those in which mullite or corundum, particularly corundum, are the first minerals to freeze out of the clear glass on cooling. While some of these mixtures are quite fluid and corrosive at ordinary boiler-operating temperatures, most of them tend to give the nonfluid, sintering type of slag. In general, this tendency increases with increasing alumina contents. However, from a great many coal ashes which are quite high in lime, anorthite ($CaO.Al_2O_3.2SiO_2$), or an iron mineral, is the first to appear in cooling. These mixtures give the type of slag which is extremely liquid and may result in a good deal of trouble. Where the mixtures are such that two or three of the minerals tend to freeze out at the same time, even more liquid slags are probable. The results in general show that in some cases (speaking from the standpoint of chemical reactions only) it may be possible to obtain longer life of refractories by shifting to a refractory of somewhat different composition, or by changing the type of coal used, or by lowering operating temperatures. However, in many cases where change of fuel is impracticable, the bad effects from the chemical standpoint may be offset to a greater or less degree by using refractories of different physical characteristics, or by change in the furnace design.

DETERMINATION OF BORON IN SPECIAL GLASSES

The method for determining boric oxide in glass, described in J. Research NBS 16, 421 (1936) RP882, is not applicable to glasses containing more than small amounts of barium, iron and zinc, and lead. Since the publication of that method, F. W. Glaze and A. N. Finn have found that the substitution of sulfuric acid for hydrochloric acid overcomes the interference of those elements.

When sulfuric acid is used, the partition coefficient, K, becomes $0.417-0.00232t$ if the temperature (t) is between 20° and 30° C. For hydrochloric acid, $K=0.668-0.0469\sqrt{t}$. That sulfuric acid can be used satisfactorily is indicated by the fact that 32 determinations were made of boric oxide in glasses and synthetic mixtures containing different amounts of barium, zinc, iron, lead, and boron, with an average difference of ± 0.06 percent between the percentage of boron present and that found.

The substitution of sulfuric for hydrochloric acid involves no change in the reported analytical procedure, except that the concentrated hydrochloric acid (sp gr 1.18) and the 1:1 acid must be replaced by 32-percent and 16-percent (by volume) sulfuric acid, respectively. Computation of the amount of boron present must be based on the partition coefficient in sulfuric acid solution, $K=0.417-0.00232t$.

Although the use of hydrochloric acid will be satisfactory in determining boron in most commercial glasses, there are many special glasses, including the large variety of optical glasses, which contain large amounts of lead, barium, and zinc. To determine boron in these glasses, one should use the sulfuric acid modification of the procedure originally reported.

ECONOMIC FEATURES OF X-RAY PROTECTION

A study of the International Recommendations for X-ray Protection shows that while they are self-consistent, they are too stringent for most conditions encountered in the usual hospital practice. Since the lead walls form a major part of the installation cost of an X-ray department, any permissible economies therein should be welcome. Based on recent studies by Lauriston S. Taylor at the Bureau, concrete walls and floors were found to provide adequate protection when used in sufficient thickness. For higher voltage ranges, costs may be reduced to one-tenth by using concrete instead of lead walls, but for voltages below 200 kv the use of lead may be economically advantageous. By considering the decrease in intensity of the X-rays with the distance from the X-ray tube, further substantial reductions in the protective walls may be made. While scattering of X-rays from a patient forms an important source of secondary radiation, its intensity has been overestimated. By considering the actual intensity and penetration of the scattered rays, the side protective walls may usually be reduced far below the thicknesses called for in the International Recommendations. The penetration of the X-rays is also decreased rapidly when they are scattered at right angles to their original direction (Compton effect). This has not been previously considered from the economic point of view, whereas its recognition permits substantial savings in any protective walls. In general it is found, as compared with the International Recommendations, that at 200 kv, costs may be reduced to one-fifth, and at 400 kv to one-tenth in new X-ray installations.

SIMPLIFICATION OF VARIETIES AND CLASSIFICATION OF METALLIC CARTRIDGES

Simplified Practice Recommendation R62–39, Metallic Cartridges, became effective on April 1. This recommendation, which is the second revision of the original program promulgated in 1927, covers the stock varieties of rifle and pistol cartridges for all purposes.

The first revision, promulgated in 1937, effected a net reduction of 24 percent in the number of stock items, and the current revision further reduces the list by 23 percent. Compared with the number of varieties of metallic cartridges produced prior to the development of this project, the present total shows a net reduction of 57 percent.

As now revised, the schedule also shows fewer classifications. It merges under center-fire cartridges the items previously grouped under center-fire pistol cartridges and center-fire rifle cartridges, the former classification being regarded as more truly descriptive of the items listed. In addition to ball, blank, and shot center-fire cartridges, the recommendation covers rim-fire cartridges of the same types.

The revised printed issue will include a brief history of the project, and will list, in addition to the acceptors, the members of the standing committee who maintain the recommendation abreast of new developments in the industry through revision.

Until the printed issue is available, free mimeographed copies of the revision may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

SIMPLIFICATION OF SHIPPING TAGS

Simplified Practice Recommendation R93–39, promulgated as of March 1, 1939, is the first revision of R93–29, Paper Shipping Tags. It covers a simplified list of sizes and of the stocks used in tag manufacture.

This recommendation originally established eight sizes of tags and eight grades of stock as standard. In the revised issue the original sizes of the tags are retained, but additional grades of stock have been included to bring the recommendation in accord with the present commercial practice, and additional properties of the various grades are listed. Data, based on a set of specifications resulting from studies made by the Tag Manufacturers Institute, are given, covering fiber content, weight, thickness, and Elmendorf tear for manila, kraft and dyed, coated, and white lined tag stocks. Only those stocks which are in frequent demand and regularly stocked by a considerable number of the manufacturers are included in the recommendation.

In approving the new schedule of tag stocks, the industry's standing committee felt that the recommendation as modified would more adequately

meet the requirements of producers, distributors, and users.

The revised printed issue will include a brief statement of the development of the project, and will list the present members of the standing committee and acceptors of the recommendation.

Until the printed issue is available, free mimeographed copies of the recommendation may be obtained from the Division of Simplified Practice, National Bureau of Standards, Washington, D. C.

SILVER RESEARCH PROJECT TO BE CONTINUED

The American Silver Producers' Research Project to develop new industrial uses for silver has been extended for a third year, dating from June 1, 1939. The allocation of the work has not yet been decided upon but will be announced shortly.

NEW AND REVISED PUBLICATIONS ISSUED DURING APRIL 1939

Journal of Research [2]

Journal of Research of the National Bureau of Standards, volume 22, number 4, April 1939 (RP1189 to RP1199, inclusive). Price 30 cents. Annual subscription, 12 issues, $3.50

Research Papers [2]

[Reprints from the December 1938 and January 1939 Journal of Research]

RP1161. Strength of a riveted steel rigid frame having a curved inner flange. Ambrose H. Stang, Martin Greenspan, and William R. Osgood. Price 10 cents.

RP1163. Heterostatic loading and critical astatic loads. A generalization of Southwell's method for the analysis of experimental observations in problems of elastic instability. L. B. Tuckerman. Price 10 cents.

RP1164. Second spectrum of xenon. Curtis J. Humphreys. Price 10 cents.

RP1165. Solubility of lead sulfate in solutions of sulfuric acid, determined by dithizone with a photronic cell. D. Norman Craig and George W. Vinal. Price 5 cents.

RP1166. Permeability of Neoprene to gases. Theron P. Sager and Max Sucher. Price 5 cents.

RP1167. Application of graphs of maximum usable frequency to communication problems. Newbern Smith, Samuel S. Kirby, and Theodore R. Gilliland. Price 5 cents.

RP1168. Note on the spectral reflectivity of rhodium. W. W. Coblentz and R. Stair. Price 5 cents.

RP1169. An improved radio meteorograph on the Olland principle. L. F. Curtiss, A. V. Astin, L. I. Stockmann, and B. W. Brown. Price 10 cents.

RP1170. X-ray diffraction patterns of crystalline sol rubber prepared from ethereal solution. George L. Clark, Siegfried T. Gross, and W. Harold Smith. Price 5 cents.

RP1171. Engineering significance of National Bureau of Standards soil-corrosion data. Kirk H. Logan. Price 5 cents.

Building Materials and Structures [2]

[Persons who wish to be notified of new publications in the "Building Materials and Structures" series as soon as they are available should write to the Superintendent of Documents, Government Printing Office, Washington, D. C., asking that their names be placed on the special mailing list maintained by him for this purpose.]

During the past month the following publications in this series have been issued:

BMS14. Indentation and recovery of low-cost floor coverings. P. A. Sigler and Myrtle B. Woodward. Price 10 cents.

BMS15. Structural properties of "Wheeling Long-Span Steel Floor" construction sponsored by the Wheeling Corrugating Co. Herbert L. Whittemore, Ambrose H. Stang, and Vincent B. Phelan. Price 10 cents.

Miscellaneous Publications [2]

M161. Report of the Twenty-eighth National Conference on Weights and Measures attended by representatives from various States, held at the National Bureau of Standards, Washington, D. C., May 31, June 1, 2, and 3, 1938. Price 30 cents.

---

[2] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents per year; Journal of Research $3.50 per year (United States and its possessions, and Canada, Colombia, Cuba, Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Newfoundland (including Labrador), Panama, and Venezuela); other countries, 70 cents and $4.50, respectively.

Technical News Bulletin [2]

Technical News Bulletin 264, April 1939. Price 5 cents. Annual subscription, 50 cents.

MIMEOGRAPHED MATERIAL

Letter Circulars

[Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards and are sent only on request to persons having definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.]

LC543. Paper and related subjects: Publications of the staff of the National Bureau of Standards. (Supersedes LC447.)

LC545. Photoelectric colorimeters. (Supersedes LC473.)

LC546. Gases: Publications by the staff of the National Bureau of Standards. (Supersedes LC80.)

LC547. Preparation and colorimetric properties of a magnesium-oxide reflectance standard. (Supersedes LC395.)

LC548. Specification for proving rings for calibrating testing machines. (Supersedes LC409.)

LC549. Information on ultraviolet transparency of window materials and fabrics. (Supersedes LC511.)

LC550. Fluorescence and phosphorescence.

Report of the National Hydraulic Laboratory

[Copies are sent only in answer to specific requests addressed to the National Bureau of Standards.]

Current hydraulic laboratory research in the United States, Bulletin VII, Series A (January 1939).

See footnote 2 on page 51.

RECENT BUREAU ARTICLES APPEARING IN OUTSIDE PUBLICATIONS [3]

Terminology and standards of illumination. E. C. Crittenden. J. Opt. Soc. Am. (Cornell University, Ithaca, N. Y.) 29, 103 (March 1939).

Standard tests guide Government in incandescent lamp buying. J. Franklin Meyer. Ind. Standardization and Commercial Standards Mo. (29 West 39th St., New York, N. Y.) 10, 21 (January 1939).

Development of a method of classifying paints according to gloss. Richard S. Hunter and Deane B. Judd. Bulletin 97, Am. Soc. Testing Materials (260 So. Broad St., Philadelphia, Pa.) 11 (March 1939).

New method of measuring deflection in the transverse-loading test of cast iron. A. I. Krynitsky and C. M. Saeger. Bulletin 97, Am. Soc. Testing Materials, 23 (March 1939).

Solubility of colored glazes in organic acids. R. F. Geller and A. S. Creamer. J. Am. Ceram. Soc. (2525 North High St., Columbus, Ohio) 22, No. 4, 133 (April 1939).

Discussion of G. H. Spencer-Strong's paper on the relation of microstructure to the enamelability of cast iron. A. I. Krynitsky. Trans. Am. Foundrymen's Assoc. (222 West Adams St., Chicago, Ill.) 46, 807 (June 1939).

National Bureau of Standards. Lyman J. Briggs. Kansas City Today (Community Service Corp., Hotel Continental, Kansas City, Mo.) 5, No. 2, 9 (February 1939). (Syndicated article in various chambers of commerce magazines.)

[3] These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

U. S. GOVERNMENT PRINTING OFFICE: 1939